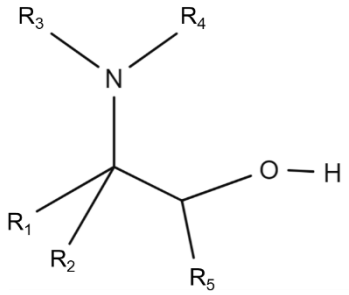
a) a pH adjusting agent;

the pH of the CMP polishing composition ranges from 3 to 11, 4 to 10, 5 to 9, or 6 to 8.

[0012] The abrasive can be any known abrasive particles, includes but is not limited to inorganic oxide particles, metal oxide-coated inorganic oxide particles, organic polymer particles, metal oxide-coated organic polymer particles, and combinations thereof.

[0013] The chemical additive includes but is not limited to amino alcohol compound having a structure A as shown below:



A

[0014] In structure A, R_1 and R_2 each independently includes but is not limited to: H; OH; C1 - C12, C1-C8, or C1-C4 alkyl; or C1 - C12, C1-C8, or C1-C4 alkyl alcohol; and R_3, R_4 and R_5 each independently includes but is not limited to: H; C1-C12, C1-C8, or C1-C4 alkyl; or C1 - C12, C1-C8, or C1-C4 alkyl alcohol.

[0015] Some examples of the chemical additive include but are not limited to 2-(dimethylamino)-2-methyl-1-propanol, 2-amino-2-methyl-1-propanol, 2-amino-2-ethyl-1,3-propanediol, 3-amino-4-octanol, 2-amino-2-hydroxymethly-1,3-propanediol, 2-amino-2-methyl-1,3-propanediol, 2-amino-1-butanol, amino-2-propanol, 2-(Isopropylamino)ethanol, and 2-(Methylamino)ethanol.

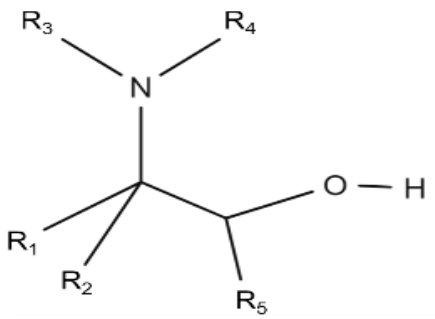
[0016] The optional chelator includes but is not limited to amino acids and derivatives, and amines.

[0017] The amino acids and amino acid derivatives included, but not limited to, glycine, D-alanine, L-alanine, DL-alanine, beta-alanine, valine, leucine, isolueciene, phenylamine, proline, serine, threonine, tyrosine, glutamine, asparanine, glutamic acid, aspartic acid, tryptophan, histidine, arginine, lysine, methionine, cysteine, iminodiacetic acid, and combinations thereof.

[0018] The optional corrosion inhibitors include but are not limited to family of hetero aromatic compounds containing nitrogen atom(s) in their aromatic rings, such as 1,2,4-

[0036] The chemical additive includes but is not limited to amino alcohol compounds.

[0037] The amino alcohol compound includes but is not limited to have a general structure A as shown below:



A;

where, R_1 and R_2 in structure A each independently includes but is not limited to: H; OH; C1 - C12, C1-C8, or C1-C4 alkyl; or C1 - C12, C1-C8, or C1-C4 alkyl alcohol; and R_3, R_4 and R_5 in structure A each independently includes but is not limited to: H; C1-C12, C1-C8, or C1-C4 alkyl; or C1 - C12, C1-C8, or C1-C4 alkyl alcohol.

[0038] Example of amino alcohol compound includes but is not limited to 2-(dimethylamino)-2-methyl-1-propanol, 2-amino-2-methyl-1-propanol, 2-amino-2-ethyl-1,3-propanediol, 3-amino-4-octanol, 2-amino-2-hydroxymethly-1,3-propanediol, 2-amino-2-methyl-1,3-propanediol, 2-amino-1-butanol, amino-2-propanol, 2-(Isopropylamino)ethanol, and 2-(Methylamino)ethanol.

[0039] The amino alcohol compound can be used alone or in combinations.

[0040] The amino alcohols feature distinct steric hindrance structures. Not to be bound by theory, in the case of these amino alcohols compounds it is believed that the steric hindrance structures exhibit the capacity for providing weak protection within the lower-lying regions of the pattern, thereby facilitating the enhancement of planarization efficiency (PE). PE can be evaluated by examining changes in film thickness at the bottom and top of the feature. It is determined by plotting the step height reduction of a specific feature (e.g., a 100mm line/space) against the removed thickness of the copper (Cu) film. The slope of this plot reflects the planarization efficiency achieved, taking into account the combination of chemicals and mechanical polish parameters used in the composition in the polishing process.

[0041] Simultaneously, owing to their relatively moderate chelation abilities, these compounds facilitate metal dissolution during the polishing process, consequently

Claims

1. A Chemical Mechanical Planarization polishing composition comprising:

a) an abrasive;

b) a chemical additive; and

c) a water-soluble solvent;

optionally at least one of

d) a chelator;

e) a corrosion inhibitor;

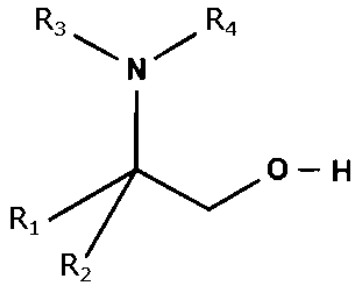
f) a biocide;

g) an organic quaternary ammonium salt;

h) an oxidizing agent; and

i) a pH adjusting agent;

wherein the chemical additive comprises amino alcohol compound having a general structure A as shown below:



A;

wherein R_1 and R_2 each independently selected from the group consisting of H; OH; C1 - C12, C1-C8, or C1-C4 alkyl; or C1 - C12, C1-C8, or C1-C4 alkyl alcohol; and R_3, R_4 and R_5 each independently selected from the group consisting of H; C1-C12, C1-C8, or C1-C4 alkyl; or C1 - C12, C1-C8, or C1-C4 alkyl alcohol; the water-soluble solvent is selected from the group consisting of deionized (DI) water, distilled water, and alcoholic organic solvents;

and
pH of the CMP polishing composition ranges from 4 to 10, or 5 to 9.

2. The Chemical Mechanical Planarization polishing composition – of Claim 1, wherein the chemical additive is selected from the group consisting of 2-(dimethylamino)-2-methyl-1-propanol, 2-amino-2-methyl-1-propanol, 2-amino-2-ethyl-1,3-propanediol, 3-amino-4-octanol, 2-amino-2-hydroxymethly-1,3-propanediol, 2-amino-2-methyl-1,3-propanediol, 2-amino-1-butanol, amino-2-propanol, 2-(Isopropylamino)ethanol, 2-Methylamino)ethanol, and combinations thereof.

3. The Chemical Mechanical Planarization polishing composition of –Claim 1 or Claim 2, wherein the chemical additive is selected from the group consisting of 2-(dimethylamino)-2-methyl-1-propanol, 2-amino-2-methyl-1-propanol, 2-amino-2-ethyl-1,3-propanediol, 3-amino-4-octanol, 2-amino-2-hydroxymethly-1,3-propanediol, amino-2-propanol, 2-(Isopropylamino)ethanol, 2-(Methylamino)ethanol, and combinations thereof.

4. The Chemical Mechanical Planarization polishing composition of any one of Claims 1 - 3, wherein the abrasive is selected from the group consisting of colloidal silica; colloidal silica particles doped by other metal oxide within lattice of the colloidal silica; silica sol selected from the group consisting of sodium silicates, potassium silicates, and combinations thereof; fumed silica; colloidal aluminum oxide selected from the group consisting of alpha-, beta-, and gamma-types of aluminum oxides; colloidal and photoactive titanium dioxide, cerium oxide, colloidal cerium oxide; nano-sized diamond particles; nano-sized silicon nitride particles; organic polymer-based soft abrasives; surface-coated or modified abrasives; and combinations thereof.

5. The Chemical Mechanical Planarization polishing composition of any one of Claims 1 - 4, wherein the abrasive is selected from the group consisting of colloidal silica; colloidal silica particles doped by other metal oxide within lattice of the colloidal silica; surface-coated or modified colloidal silica; and combinations thereof.

6. The Chemical Mechanical Planarization polishing composition of any one of Claims 1 - 5, wherein the abrasive is selected from the group consisting of colloidal silica; surface-coated or modified colloidal silica; and combinations thereof.

7. The Chemical Mechanical Planarization polishing composition of any one of Claims 1 - 6, where the chelator is selected from the group consisting of amino acid and derivatives, amines, and combinations thereof.

8. The Chemical Mechanical Planarization polishing composition of any one of Claims 1 - 7, where the chelator is amino acid or its derivatives selected from the group consisting of glycine, D-alanine, L-alanine, DL-alanine, beta-alanine, valine, leucine, isolueciene, phenylamine, proline, serine, threonine, tyrosine, glutamine, asparanine, glutamic acid, aspartic acid, tryptophan, histidine, arginine, lysine, methionine, cysteine, iminodiacetic acid, and combinations thereof.

9. The Chemical Mechanical Planarization polishing composition of any one of Claims 1 - 8, where the chelator is a combination of at least two amino acids or their derivatives selected glycine, D-alanine, L-alanine, DL-alanine, beta-alanine, their derivatives, and combinations thereof.

10. The Chemical Mechanical Planarization polishing composition of any one of Claims 1 - 9, wherein the corrosion inhibitor is a hetero aromatic compound containing nitrogen atom(s) in the aromatic rings.

11. The Chemical Mechanical Planarization polishing composition of any one of Claims 1 - 10, wherein the corrosion inhibitor is selected from the group consisting of 1,2,4-triazole, benzotriazole and benzotriazole derivatives, tetrazole

and tetrazole derivatives, imidazole and imidazole derivatives, benzimidazole and benzimidazole derivatives, pyrazole and pyrazole derivatives, tetrazole and tetrazole derivatives, and combinations thereof.

12. The Chemical Mechanical Planarization polishing composition of any one of Claims 1 - 11, wherein the biocide comprises ingredient selected from the group consisting of 5-chloro-2-methyl-4-isothiazolin-3-one, 2-methyl-4-isothiazolin-3-one and combinations thereof.

13. The Chemical Mechanical Planarization polishing composition of any one of Claims 1 - 12, wherein the oxidizer is a peroxy compound selected from the group consisting of hydrogen peroxide, urea peroxide, peroxyformic acid, peracetic acid, propaneperoxoic acid, substituted or unsubstituted butaneperoxoic acid, hydroperoxy-acetaldehyde, potassium periodate, ammonium peroxymonosulfate; and non-per-oxy compound selected from the group consisting of ferric nitrite, $KClO_4$, $KBrO_4$, $KMnO_4$; and combinations thereof.

14. The Chemical Mechanical Planarization polishing composition of any one of Claims 1 - 13, wherein the oxidizer is hydrogen peroxide.

15. The Chemical Mechanical Planarization polishing composition of any one of Claims 1 - 14, wherein the pH adjusting agent is selected from the group consisting of(a)nitric acid, sulfuric acid, tartaric acid, succinic acid, citric acid, malic acid, malonic acid, various fatty acids, various polycarboxylic acids, and mixtures thereof to lower the pH; and (b) potassium hydroxide, sodium hydroxide, ammonia, tetraethylammonium hydroxide, ethylenediamine, piperazine, polyethyleneimine, modified polyethyleneimine, and mixtures thereof to raise the pH.

16. The Chemical Mechanical Planarization polishing composition of any one of Claims 1 - 15, wherein the Chemical Mechanical Planarization polishing composition comprises at least one selected from the group consisting of colloidal

silica, fumed silica, silica sol of sodium silicates or potassium silicates; at least one selected from the group consisting of glycine and alanine; at least one selected from the group consisting of 2-(dimethylamino)-2-methyl-1-propanol, 2-amino-2-methyl-1-propanol, 2-amino-2-ethyl-1,3-propanediol, 3-amino-4-octanol, 2-amino-2-hydroxymethly-1,3-propanediol, 2-amino-2-methyl-1,3-propanediol, 2-amino-1-butanol, and combinations thereof; and has a pH of 5 to 9, or 6 to 8.

17. A Chemical Mechanical Planarization polishing method for polishing a semiconductor substrate comprising at least one surface containing Cu, comprising:
contacting the at least one surface with a polishing pad;
delivering the chemical mechanical planarization polishing composition of any one of Claims 1 - 17;
polishing the at least one surface containing Cu with the chemical mechanical planarization composition.

18. The Chemical Mechanical Planarization polishing method of Claim 17, wherein the semiconductor substrate comprising at least another surface containing a second material; removal selectivity of Cu vs the second material is > 1, >5, or > 6; and the second material is selected from the group consisting of Ta; Ti; TaN; TiN; Ta; TaN; Ti; TiN; SiO_2, SiN, SiC; and low-k and ultra-low-k material.

19. A Chemical Mechanical Planarization polishing system, comprising:
a semiconductor substrate comprising at least one surface containing Cu;
a polishing pad; and
the chemical mechanical planarization polishing composition of any one of Claims 1 to 16;
wherein the at least one surface containing Cu is in contact with the polishing pad and the chemical mechanical planarization composition.

20. The Chemical Mechanical Planarization polishing system of Claim 19;
wherein the semiconductor substrate comprising at least another surface containing a second material; removal selectivity of Cu vs the second material is > 1, >5, or > 6; and
the second material is selected from the group consisting of Ta; Ti; TaN; TiN; Ta; TaN; Ti; TiN; SiO_2; SiN; SiC; and low-k and ultra-low-k material.